an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to a leading edge with the same sweep angle as an outward boundary of the intermediate region to provide a sweep angle that causes the blade to intercept the shock.

REMARKS

The applicants would like to express their gratitude for the courtesies extended to their representatives at the interview on May 14, 2003. The substance of the interview is recorded in the Examiner's Interview Summary prepared contemporaneously with the interview. These Remarks make reference to the interview where appropriate.

To expedite prosecution of the present application and declaration of an interference with U.S. Patent 6,071,077 ("the Rolls '077 Patent"), the applicants have canceled rejected claims 10, 11, 13-17, and 20.

The claims remaining in the application are independent claim 18, its dependent claims 19 and 22, and independent claim 23. Rejected claims 18, 19, and 23 have been amended to remove all of the language the Examiner said was unsupported and/or indefinite under 35 U.S.C. § 112, first and second paragraphs, and replace it with language consistent with the comments in the Office Action. (The applicants reserve the right to contest the grounds for the rejections if necessary at a later date.)

Appendix A indicates the status of all of the claims in the present application and shows the claim changes by underlining added text and placing deleted text in brackets.

Regarding the proposed interference with the Rolls '077 Patent, the claim changes do not alter the fact that the applicants' claims are, as stated in the Office Action, "essential copies" of claims in the Rolls '077 Patent. In view of the claim changes, the applicants propose setting up

the interference slightly differently from the manner discussed in the Supplemental Preliminary Amendment, Information Disclosure Statement, and Request for an Interference, dated July 19, 2002 ("Original Request for an Interference"). Now, only the applicants' claims 18, 19, 22, and 23 will be involved in the interference, since the remaining claims have been canceled. However, all of the Rolls '077 Patent claims will still be involved in the interference because they represent the same patentable invention as the applicants' claims.

The only other change in how the applicants propose setting up the interference concerns the single interference count, comprising either the applicants' claim 18 or 23 or Rolls '077 Patent claim 1 or 8. Thus, all of the independent claims in the present application and the Rolls '077 Patent are proposed as count alternatives, in accordance with current interference practice. Proposed Count 1 is formulated in this manner so that each party will have the opportunity to establish its priority right using proof of pre-filing date activity (conception, diligence, and actual reduction to practice) relating to any embodiment representing the parties' common invention.

Other than a slightly different interference count and the reduction in the number of the applicants' claims, the manner in which the applicants propose setting up the interference is as set forth in the Original Request for an Interference. However, the showing required by 37 C.F.R. § 1.607(a), applied to the present case as currently constituted, is included below for the sake of completeness. That showing is now supported by the expert testimony in the accompanying Declaration of Frans A.E. Breugelmans ("the Breugelmans Declaration").

Before discussing their revised proposal for an interference, the applicants will explain how the claim changes respond to the rejections in the Office Action.

I. RESPONSE TO OFFICE ACTION

For the record, the applicants believe that all of the rejected claims were fully supported by the present application. Moreover, many of the rejections are equally applicable to the issued patent claims from which the rejected claims were taken, and thus required the approval of the Technology Center Director, per the Manual of Patent Examining Procedure § 2307.02 at 2300-15 (August 2001) ("M.P.E.P."). Nevertheless, the applicants have made the claim changes herein because the resulting claims still support the sought-after interference with the Rolls '077 Patent.

A. Amendments To Rejected Claims 18, 19, And 23

1. Claim 18. This claim was rejected under 35 U.S.C. § 112, first and second paragraphs, on several grounds.

a. Claim 18 was rejected first because it recites that the claimed fan stage is "at least in part" rotatable about an axis of rotation. This recitation originated in claim 8 of the Rolls '077 Patent, which discloses a fan stage rotatable in exactly the same manner as the present application's fan stage, and was apparently meant to take into account the fact that what is claimed comprises both a stationary portion (the fan casing) and a rotating portion (the hub and rotor). The recitation has been deleted from the applicants' claim 18.

b. The Office Action next contended that there is no support in the present application for claim 18's inner duct wall that is convergent "at the fan rotor region." This recitation has been deleted.

The Office Action acknowledged that the present application discloses a convergent duct wall. In keeping with the PTO practice of giving claims their broadest reasonable interpretation, M.P.E.P. § 2111, the applicants believe that Figure 2 of the present application shows the

convergent part of the duct wall at the region of the fan rotor, because the leading edge 28 of the blade 12 at $r_{t\text{-inner}}$ is within the converging portion of the duct wall. However, the applicants have elected to delete the recitation rather than contest the rejection based on it.

c. The third rejection of claim 18 was related to the second, in that the Office Action said that the blade tip does not correspond to the convergent duct wall. The Examiner apparently read the claim language as requiring that the blade tip be convergent, even though claim 18 intentionally omitted that feature of Rolls '077 Patent claim 8.

The language presented here represents a slightly different approach from that discussed at the interview. Upon further reflection, the applicants were concerned that the language discussed at the interview could have been read to exclude the claim from covering a fan stage with a convergent duct wall and corresponding convergent blade tips. By removing from claim 18 explicit mention of either a convergent duct wall or convergent blade tips, the claim clearly covers such an arrangement.

In a telephone interview on May 15, 2003, the Examiner agreed that this ground of rejection is obviated by removing from claim 18 the recitation of a convergent duct wall. Figs. 1 and 2 of the application show that the blade tips correspond to the duct wall.

d. The next rejection was related to the previous two, in that the Office Action contended that reciting the duct wall as "substantially" convergent renders the claim indefinite. This recitation has been deleted from claim 18, even though it was applicable to Rolls '077 Patent claim 8, from which the applicants took their claim 18.

e. The last rejection of claim 18 was based on language relating to the forward translation of the blade outer region. The applicants had intended to recite this feature using the same language as parent application No. 09/343,736 (now U.S. Patent No. RE38,040), which

was allowed by the Examiner of the present application. The applicants apologize for that misunderstanding.

In summary, amended claim 18 complies with the requirements of 35 U.S.C. § 112, second paragraph, and is supported in accordance with 35 U.S.C. § 112, first paragraph. See also Breugelmans Declaration, para. 66.

2. Claim 19. The present application supports claim 19 in the same manner that the Rolls '077 Patent supports its claim 9. Nevertheless, the applicants have amended claim 19 to reflect their interpretation of Rolls's claim 9. Amended claim 19 is supported by Figure 2. See also Breugelmans Declaration, paras. 53-54 and 67-68.

3. Claim 22. No separate ground of rejection was directed to this claim, and it has not been amended. Claim 22 is supported in accordance with 35 U.S.C. § 112, first paragraph. See also Breugelmans Declaration, paras. 69-70.

4. Claim 23. The same rejections applied to claim 18 were applied to claim 23. It has been amended similarly.

Amended claim 23 complies with the requirements of 35 U.S.C. § 112, second paragraph, and is supported in accordance with 35 U.S.C. § 112, first paragraph. See Breugelmans Declaration, para. 71.

Canceled claims 10, 11, 13-17, and 20. Appendix B discusses why the rejections of these claims were in fact not well taken. This is done to foreclose any implication that the applicants have acquiesced in the rejections, should it be necessary later to introduce the canceled claims, or claims similar to them, in an interference with the Rolls '077 Patent.

B. Objection to Supplemental Reissue Declaration

The Office Action indicated that the Supplemental Reissue Declaration now on file is defective for failing to state the citizenship of the representative of the estate of deceased inventor David A. Spear.

At the interview, it was determined that the claim amendments presented herein require another Supplemental Reissue Declaration. It was also suggested at the interview that a Proposed Supplemental Reissue Declaration be submitted for approval prior to execution.

As discussed at the interview, the applicants will obtain the necessary execution of the enclosed Proposed Supplemental Reissue Declaration upon final approval thereof by the Examiner and after the final form of the claims has been determined.

C. Statement re Surrender of Original Letters Patent

As requested in the Office Action, a separate paper is enclosed confirming that original U.S. Letters Patent No. 5,642,985 was surrendered in parent reissue application No. 09/343,736. The form of the enclosed separate paper to that effect was approved at the interview.

II. REVISED REQUEST FOR AN INTERFERENCE

A. The Present Application and the Rolls '077 Patent Still Interfere

As noted in the Original Request for an Interference, the present application seeks reissue of U.S. Patent No. 5,642,985, assigned to United Technologies Corporation of Hartford, Connecticut ("UTC"). The present application, also assigned to UTC, was filed to provoke an interference with the Rolls '077 Patent.

As mentioned above, the alternate versions of proposed Count 1 of the interference are either the amended version of the applicants' claim 18 or claim 23 or Rolls '077 Patent claim 1 or claim 8. None of the above changes to claims 18 and 23 affect the reasons set forth in the

Original Request for an Interference as to why those claims and Rolls '077 Patent claims 1 and 8 define the same patentable invention. See Original Request for an Interference at 7-12, 14-17. See also Breugelmans Declaration, paras. 8-33.

B. Showing under 37 C.F.R. § 1.607(a)

1. 37 C.F.R. § 1.607(a)(1) -- Identification of the Patent

The patent is the Rolls '077 Patent.

2. 37 C.F.R. § 1.607(a)(2) -- Proposed Count 1

UTC proposes that the interference be declared with a single count in accordance with the following proposed Count 1:

> A fan stage of a ducted fan gas turbine engine according to claim 18 or claim 23 of application No. 09/874,931 or claim 1 or claim 8 of U.S. Patent No. 6,071,077.

These alternate versions of an interference count are put forward pursuant to the discussion in the Original Request for an Interference, at 15-16. Specifically, the applicants' claim 18 and Rolls '077 Patent claim 8 are proper alternate versions of proposed Count 1 because they are in all relevant respects broader than any other claim in the parties' respective cases. Breugelmans Declaration, para. 20. As between those two claims, the subject matter of narrower Rolls '077 Patent claim 8 would have been obvious from the subject matter of broader present claim 18 for the reasons set forth in paragraphs 20-30 of the Breugelmans Declaration. Conversely, Rolls '077 Patent claim 8 anticipates the applicants' claim 18, since a narrow claim anticipates a broader claim. Chisum on Patents § 3.02[1], at 3-14, and [2], at 3-20 to 3-21. M.P.E.P. § 2131.02.

The next alternate version of proposed Count 1 is the applicants' independent claim 23, which is properly included in Count 1 for the reasons discussed above at page 4. Claim 23 is identical to claim 18, except that claim 23 adds as a feature of the invention that the blade creates

a shock at the duct wall and moves the blade tip forward to intercept it. As compared with Rolls '077 Patent claim 8 and the applicants' claim 18, the feature added to the applicants' claim 23 simply recites explicitly a function of the blades in Rolls '077 Patent claim 8 (as taught by the Rolls '077 Patent) and present claim 18 (as taught by the present application). For the reasons stated in paragraphs 30-31 of the Breugelmans Declaration, the subject matter of Rolls '077 Patent claim 8 and the applicants' claim 18, on the one hand, and the subject matter of the applicants' claim 23, on the other, represent the same patentable invention.

Rolls '077 Patent claim 1 constitutes the last alternate version of proposed Count 1. The difference between Rolls '077 Patent claims 1 and 8 (other than differences in terminology that do not affect this analysis) is that claim 1 recites a "stagger angle which increases progressively with blade height," a limitation not found in claim 8. However, one skilled in the art at the time of the invention knew that to be a necessary feature of all fan blades. See U.S. Patent 4,012,172 to Schwaar et al.; Breugelmans Declaration, Exhibit 2, paras. 20-21. Accordingly, the subject matter of Rolls '077 Patent claim 1, on the one hand, and the subject matter of Rolls '077 Patent claim 8 and the applicants' claims 18 and 23, on the other, represent the same patentable invention. Breugelmans Declaration, paras. 32-33.

3. 37 C.F.R. § 1.607(a)(3) -- Rolls '077 Patent
Dependent Claims 2-7 and 9-13 Correspond to Count 1

A claim corresponds to an interference count when they both define the same patentable invention. See 37 C.F.R. § 1.601(f) and (i); see also 37 C.F.R. § 1.606. The definition of "same patentable invention" is found in 37 C.F.R. § 1.601(n). This "same patentable invention" inquiry requires two-way obviousness (count-to-claim and claim-to-count).

The subject matter of Rolls '077 Patent dependent claims 2-7 and 9-13 would have been obvious from each of the alternate versions of proposed Count 1 for the reasons set forth in

paragraphs 34-62 of the Breugelmans Declaration. As dependent claims, they are narrower than each of the alternate versions of proposed Count 1 and therefore anticipate proposed Count 1. Chisum on Patents, supra; M.P.E.P., supra.

4. 37 C.F.R. § 1.607(a)(4) -- Applicants' Dependent Claims 19 and 22 Correspond to Count 1

The applicants' dependent claims 19 and 22 would have been obvious from each of the alternate versions of proposed Count 1 for the reasons set forth in paragraph 63 of the Breugelmans Declaration. As dependent claims, they are narrower than each of the alternate versions of proposed Count 1 and therefore anticipate proposed Count 1. Id.

5. 37 C.F.R. § 1.607(a)(5) -- The Present Application Supports Applicants' Claims 18, 19, 22, and 23

All of the applicants' claims are all supported by the present application as set forth in paragraphs 65-71 of the Breugelmans Declaration.

6. 37 C.F.R. § 1.607(a)(6) -- The Requirements of 35 U.S.C. § 135(b) are Met

This is covered in the Original Request for an Interference, at 32.

C. Summary of Interference

The interference should be declared with UTC as the senior party and Rolls-Royce PLC as the junior party, in the following manner:

Count 1

A fan stage of a ducted fan gas turbine engine according to claim 18 or claim 23 of application No. 09/874,931 or claim 1 or claim 8 of U.S. Patent No. 6,071,077

Claims designated as corresponding to Count 1

U.S. Patent 6,071,077: claims 1-13
Application No. 09/874,931: claims 18, 19, 22, and 23

Claims designated as not corresponding to Count 1

U.S. Patent 6,071,077: none
Application No. 09/874,931: none

Effective filing dates

UTC: Nov. 17, 1995
Rolls: Oct. 9, 1998

It was agreed at the interview that the Examiner will contact the applicants' representative concerning an additional personal interview if the Examiner either disagrees that there is interfering subject matter in the present application and U.S. Patent 6,071,077 or determines that the interference should be declared in any manner other than as stated here.

III. INFORMATION DISCLOSURE STATEMENT

The Examiner is requested to consider U.S. Patent No. RE38,040 listed on the enclosed Form PTO-1449 and return a copy of the Form PTO-1449 indicating that the patent has been considered.

IV. SUMMARY

The Examiner is again requested to forward the present application to the Board of Patent Appeals and Interferences pursuant to 37 C.F.R. § 1.609(a) for declaration of an interference.

To assist the Examiner in preparing the application for the requested interference, a new completed Form PTO-850 and accompanying Interference Initial Memorandum, with which the Examiner can forward the application to the Board, are attached as Appendix C. The enclosed floppy disc containing the Form PTO-850 and Interference Initial Memorandum in Microsoft® Word XP® will facilitate any editing of those documents that the Examiner may wish to do.

Any fees due on account of this paper, including the Information Disclosure Statement, may be charged to Deposit Account No. 50-0409.

All correspondence should continue to be sent to the attorney named below at the address shown.

Respectfully submitted,

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APPENDIX A

Pursuant to 37 C.F.R. § 1.173(c), the following shows the current status of claims 1-23 of the above-identified application upon entry of the Amendment, Information Disclosure Statement, and Revised Request for an Interference of May 16, 2003 ("Amendment"), submitted herewith. Claim changes made by the Amendment are shown by underlining added text and placing deleted text in brackets. The present application supports the amended claims as discussed in the Breugelmans Declaration, para. 65-71.

Claims 1-17. (Canceled).

Claim 18. (Twice amended) A fan stage of a ducted fan gas turbine engine that is [at least in part] rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:

a fan casing that defines an inner duct wall having a fan rotor region [, the inner duct wall of the fan casing at the fan rotor region being convergent];

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:

a tip profile that [substantially] corresponds to the [convergent] inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to a [the] leading edge with the same sweep angle as [at] an outward boundary of the intermediate region.

Claim 19. (Amended) The fan stage according to claim 18, wherein the leading edge at a boundary between the intermediate region and the inner region extends further upstream along the axis of rotation than the leading edge of the inner region [along the axis of rotation].

Claims 20 and 21. (Canceled).

Claim 22. (Original) The fan stage according to claim 18, wherein each of the multiple swept fan blades includes a hub contacting surface that extends further than the tip profile along the axis of rotation.

Claim 23. (Amended) A fan stage of a ducted fan gas turbine engine that is [at least in part] rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:

a fan casing that defines an inner duct wall having a fan rotor region [, the inner duct wall of the fan casing at the fan rotor region being convergent];

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub and being capable of rotating at speeds providing supersonic working medium gas velocities over the blades to cause a shock in the gas adjacent the inner duct wall, each of the multiple swept fan blades having:

a tip profile that [substantially] corresponds to the [convergent] inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to a [the] leading edge with the same sweep angle as [at] an outward boundary of the intermediate region to provide a sweep angle that causes the blade to intercept the shock.

APPENDIX B

The following explains why the rejections of claims 10, 11, 13-17, and 20, in the above-identified application, canceled in the Amendment, Information Disclosure Statement, and Revised Request for an Interference of May 16, 2003 ("Amendment"), submitted herewith, were in fact not well taken.

Claim 10. The rejection of this claim included the last four grounds of rejection applied to claim 18, and the discussion at pages 6-8 of the Amendment (sections I.A.1.b. to I.A.1.e.) applies equally to claim 10.

Claim 10 was also rejected because it recites that the blade stagger angle "increases progressively with blade height." This feature is inherently disclosed in the present application by virtue of the discussion at column 3, lines 3-6, when taken with established principles for constructing gas turbine engine fan blades, as described in prior art such as U.S. Patent 4,012,172 to Schwaar et al. See also Breugelmans Declaration, para. 33.

Claim 11. The principal ground of rejection of this claim is understood to have been directed to the recitation that the stagger angle increases to less than 90° at the blade tip relative to the airflow direction.

Initially, the stagger angle in any fan blade increases from the root to the tip, as discussed above in connection with claim 10. In addition, Figure 3 of the present application (which corresponds to Figure 5c of the Rolls '077 Patent) shows that the stagger angle at the blade tip is less than 90º relative to the airflow direction, as recited in claim 11.

Claim 13. No separate ground of rejection was directed to this claim.

Claim 14. The subject matter of this claim was related to the stagger angle recitations in claims 10 and 11, and is inherently disclosed in the present application for the same reasons discussed above in connection with claims 10 and 11. That is, since the stagger angle of all fan blades must increase from root to tip, the stagger angle in a blade mid-height region will necessarily be a predetermined fraction of the stagger angle at the blade tip, as recited in canceled claim 14.

Claim 15. The subject matter of this claim involved the concept of a Mach cone and the relation of the blade leading edge sweep angle to the complement of the Mach cone. For the reasons explained in the Breugelmans Declaration, paras. 42-45, claim 15 is no more than a restatement of the leading edge geometry in claim 10 using different words. Since the present application discloses that geometry, it perforce supports claim 15.

Claim 16. This claim does no more than recite a necessary property of all gas turbine engine swept fan blades, as discussed in the Breugelmans Declaration, paras. 46-48. Since the present application discloses a swept fan blade for a gas turbine engine, it also discloses the subject matter of this claim.

Claim 17. The subject matter of this claim is supported for the same reasons as the subject matter of claim 15. See Breugelmans Declaration, paras. 49-52.

Claim 20. This claim has been canceled because it recited the same subject matter as claim 18 and therefore was redundant. It was based on Rolls claim 10, which is likewise redundant of Rolls claim 8. During prosecution of the Rolls '077 Patent application, the limitations of claim 10 were incorporated into claim 8, but claim 10 was not canceled. It is thus unnecessary to include in the present application a counterpart of Rolls's claim 10.

APPENDIX C

INTERFERENCE INITIAL MEMORANDUM

BOARD OF PATENT APPEALS AND INTERFERENCES: An interference is found to exist between the following cases:

This interference involves 2 parties

PARTY	APPLICATION NO.	FILING DATE	PATENT NO., IF ANY	ISSUE DATE, IF ANY
Spear et al.	09/874,931	June 5, 2001		

If application has been patented, have maintenance fees been paid? _____Yes _____No __X__ Maintenance fees not due yet

**Accorded the benefit of:

COUNTRY	APPLICATION NO.	FILING DATE	PATENT NO., IF ANY	ISSUE DATE, IF ANY
United States	09/343,736	June 30, 1999	RE38,040	March 18, 2003
United States	08/559,965	November 17, 1995	5,642,985	July 1, 1997

The claim(s) of this party which correspond(s) to this count is (are): **PATENTED OR PATENTABLE PENDING CLAIMS**	**UNPATENTABLE PENDING CLAIMS**
18, 19, 22, and 23	None
The claim(s) of this party which does (do) not correspond(s) to this count is (are): **PATENTED OR PATENTABLE PENDING CLAIMS**	**UNPATENTABLE PENDING CLAIMS**
None	None

PARTY	APPLICATION NO.	FILING DATE	PATENT NO., IF ANY	ISSUE DATE, IF ANY
Rowlands	09/168,968	October 9, 1998	6,071,077	June 6, 2000

If application has been patented, have maintenance fees been paid? _____Yes _____No __X__ Maintenance fees not due yet

**Accorded the benefit of:

COUNTRY	APPLICATION NO.	FILING DATE	PATENT NO., IF ANY	ISSUE DATE, IF ANY

The claim(s) of this party which correspond(s) to this count is (are): **PATENTED OR PATENTABLE PENDING CLAIMS**	**UNPATENTABLE PENDING CLAIMS**
1-13	Does not apply
The claim(s) of this party which does (do) not correspond(s) to this count is (are): **PATENTED OR PATENTABLE PENDING CLAIMS**	**UNPATENTABLE PENDING CLAIMS**
None	Does not apply

Instructions

1. For every patent involved in the interference, check if the maintenance fees have been paid by using the patent number with PALM screen 2970. If fees are due and they have not been paid, the interference cannot be declared since it would involve an expired patent. (35 U.S.C. 135(a); 37 CFR 1.606).
2. For each party, separately identify the patentable and unpatentable claims which correspond to the count. (37 CFR 1.601(f), 1.601(n), 1.609(b)(2)).
3. For each party, separately identify the patentable and unpatentable claims which do not correspond to the count (37 CFR 1.609(b)(3)).
4. Forward all files including those the benefit of which is being accorded.
5. Keep a copy of the Interference Initial Memorandum and any attachments for your records.

All information requested below must be attached on (a) separate typewritten sheet(s)

6. On a separate sheet, set forth a single proposed interference count. If any claim or any party is exactly the same word for word as this count, please indicate the party, application or patent number, and the claim number.
7. For each claim designated as corresponding to the count, provide an explanation of why each claim defines the same patentable invention as the count (37 CFR 1.609(b)(2)).
8. For each claim designated as not corresponding to the count, provide an explanation of why each claim defines a separate patentable invention from the count (37 CFR 1.609(b)(3)).
9. For each additional count, if any, repeat steps 2-6 and, additionally, provide an explanation why each count represents a separate patentable invention from every other count (37 CFR 1.609(b)(1)).

DATE	PRIMARY EXAMINER (Signature)	TELEPHONE NO.	ART UNIT
	Christopher Verdier	703-308-2638	3745
DATE	GROUP DIRECTOR SIGNATURE (If required)		

**The application number and filing date of each application the benefit of which is intended to be accorded must be listed. It is not sufficient to merely list the earliest application if there are intervening applications necessary for continuity.

THIS PAGE CAN BE DUPLICATED IF THERE ARE MORE THAN TWO INTERFERING PARTIES.

COUNT

A fan stage of a ducted fan gas turbine engine according to

Claim 18 of Application No. 09/874,931 (Alternate A)

OR

Claim 23 of Application No. 09/874,931 (Alternate B)

OR

Claim 1 of Patent No. 6,071,077 (Alternate C)

OR

Claim 8 of Patent No. 6,071,077 (Alternate D)

Claims 18 and 23 of Application No. 09/874,931 and claims 1 and 8 of Patent No. 6,071,077 All Define the Same Patentable Invention

The Count is patentable over the prior art of record because the prior art fails to show a fan stage of a ducted fan gas turbine engine comprising a fan blade having a leading edge that, in a direction outward from the fan axis of rotation, has an inner region with a forward sweep angle, an intermediate region having a rearward sweep angle, and an outer region translated forward relative to a leading edge with the same sweep angle as an outward boundary of the intermediate region so as to have a decreased sweep angle. The closest prior art of record is represented by fan blades such as those shown in U.S. Patents No. 4,012,172 to Schwaar et al. and No. 4,726,737 to Weingold et al. Those fan blades have leading edges that are swept forward in an inner region and then swept rearward. However, the prior art does not show such a fan blade having a decreased sweep angle in an outer region.

Claim 18 of Application No. 09/874,931 (Alternate A) and claim 8 of Patent No. 6,071,077 (Alternate D) are broader in all relevant respects than any other claim in Application No. 09/874,931 or U.S. Patent No. 6,072,077.

The following table shows Alternate A and Alternate D of the Count side-by-side.

Count Alternate A	Count Alternate D
A fan stage of a ducted fan gas turbine engine that is rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:	A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:
a fan casing that defines an inner duct wall having a fan rotor region;	a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;
a hub disposed concentrically relative to the fan casing;	a hub disposed concentrically relative to the fan casing;
a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:	a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:
a tip profile that corresponds to the inner duct wall of the fan casing;	a tip profile that is convergent so as to substantially correspond to the convergent inner duct wall of the fan casing;
a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:	a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:
an inner region adjacent the hub, the inner region defining a forward sweep angle;	an inner region adjacent the hub, the inner region defining a forward sweep angle;
an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and	an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and
an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to a leading edge with the same sweep angle as an outward boundary of the intermediate region.	an outer region between the intermediate region and the fan casing, the outer region defining a forward sweep angle.

Alternate A and Alternate D of the Count define the same patentable invention under 37 C.F.R. § 1.601(n).

As for the obviousness of narrower Alternate D (claim 8 of Patent No. 6,071,077) from broader Alternate A (claim 18 of Application No. 09/874,931), the first limitation in Alternate D not found in Alternate A is that the fan stage is "at least in part" rotatable. This recitation adds nothing of substance to Alternate D. Initially, the recitation appears in the count preamble and does not recite any structural feature of the fan stage itself. In addition, the rotatable parts of the fan stage recited in Alternate A (the hub and the rotor) are rotatable in the same fashion as the corresponding parts in Alternate D.

The next limitation in Alternate D but not Alternate A is a duct wall that is convergent at the fan rotor region and a blade tip profile that is convergent so as to substantially correspond to the convergent inner duct wall of the fan casing.

One of ordinary skill in the art would have used Alternate D's convergent duct wall and matching convergent blade tips in Alternate A's fan stage for a number of reasons. First, fans with convergent casings and matching convergent blade tip profiles had been conventional for decades by the filing dates of Application No. 09/874,931 and Patent No. 6,071,077, as shown in Fig. 1 of U.S. Patent 4,408,957 to Kurzrock et al., Fig. 2 of U.S. Patent 5,408,826 to Stewart et al., and Fig. 1 of Schwaar.

In addition, Patent No. 6,071,077, from which Alternate D is taken, does not assert that a convergent duct wall and matching blade tip profile, in combination with the disclosed blade leading edge geometry, provides any advantage that would not have been known to those skilled in the art. Patent No. 6,071,077, at column 6, lines 21-26, points to the discussion of a convergent casing in Patent No. 5,642,985, which is being reissued by Application No.

09/874,931 (from which Alternate A is taken). However, Patent No. 6,071,077 misconstrues what Patent No. 5,642,985 says in that regard. The discussion in Patent No. 5,642,985 (and Application No. 09/874,931) teaches that the casing wall can be made convergent to ameliorate the problem of pressure wave reflection, noting at the same time that mechanical and aerodynamic constraints may not permit sufficient convergence to eliminate the shock problem. Application No. 09/874,931, col. 3, lines 58-63. Then, just like Patent No. 6,071,077, Application No. 09/874,931 says that the blade configuration provides the solution. Col. 3, lines 64-67.

Furthermore, the prior art teaches the conventionality of providing Alternate A's fan with a convergent blade tip profile that substantially corresponds to a convergent fan casing. It was conventional to provide gas turbine engine fans with convergent casings and matching convergent fan blade tip profiles, as shown by Schwaar, Kurzrock, and Stewart. Stewart also emphasizes the importance of making the radial clearance between the convergent blade tips and converging wall casing as small as possible to minimize "efficiency damaging air leakage across the blade tips." Stewart does this by providing an abradable coating 25 on the convergent casing and cutting a convergent path through the coating with the convergent blade tips to ensure that the convergent casing and blade tips conform exactly. Stewart, Fig. 2; col. 3, lines 45-50.

Accordingly, one of ordinary skill in the art would have provided Alternate A's fan stage with a convergent blade tip profile that substantially corresponds to the convergent wall casing.

The only other difference between Alternate A and Alternate D is that Alternate A recites an outer region that is "translated forward relative to a leading edge with the same sweep angle as an outward boundary of the intermediate region." Alternate D recites this feature differently, calling for an outer region "defining a forward sweep angle."

Application No. 09/874,931, from which Alternate A is taken, teaches that the blade tip leading edge must be moved forward a sufficient distance to intercept the shock wave at the duct wall. Once one skilled in the art had been taught by Alternate A to translate the outer region forward, that person would have known to translate the outer region sufficiently to provide a forward sweep angle to intercept the shock wave under all circumstances. Stated another way, Alternate A's blade reduces leading edge sweep in an outer or tip region for the same reason as Alternate D's blade: to move the shock behind the blade leading edge so the blade intercepts the shock at the fan casing. See Application No. 09/874,931, col. 4, lines 1-6; col. 4, line 63, to col. 5, line 4; Patent No. 6,071,077, col. 4, lines 18-21. Accordingly, a fan engineer of ordinary skill would have known from Alternate A to translate the leading edge at the tip of the blade forward as far as necessary to intercept the shock there.

Accordingly, the subject matter of Alternate D would have been obvious from the subject matter of Alternate A, assuming the subject matter of Alternate A to be prior art with respect to Alternate D in accordance with 37 C.F.R. § 1.601(n). In addition, Alternate A is broader in all respects than Alternate D, because Alternate D includes limitations omitted from Alternate A. Alternate D thus anticipates Alternate A. M.P.E.P. § 2131.02, Aug. 1991 (8th ed).

Alternate B is identical to Alternate A, except that Alternate B recites a shock at the duct wall and calls for the blade leading edge to be translated forward to provide a sweep angle that intercepts the shock. Accordingly, Alternate B simply recites explicitly a feature both of Alternate A, as taught by Application No. 09/874,931 (from which Alternate A is taken), at column 4, lines 1-6, and column 4, line 63, to col. 5, line 4, and of Alternate D, as taught by Patent No. 6,071,077 (from which Alternate D is taken), at column 4, lines 18-21.

Therefore, the subject matter of either Alternate A or Alternate D would have taught one of ordinary skill in the art the subject matter of Alternate B.

In addition, Alternate B is narrower in all respects than Alternate A, and therefore Alternate B anticipates Alternate A. M.P.E.P., supra.

Alternate B does not include the limitations in Alternate D discussed above in connection with Alternate A. However, Alternate B is identical to Alternate A, except that Alternate B explicitly recites the shock-intercepting feature of the blade of both Alternate A and Alternate D. Accordingly, the subject matter of Alternate B would have taught one of ordinary skill in the art the subject matter of Alternate D, as discussed above in connection with Alternate A.

The difference between Alternate C and Alternate D (other than minor differences in terminology) is that Alternate C adds to Alternate D a "stagger angle which increases progressively with blade height."

Any fan blade's stagger angle (or "blade twist") must increase progressively with blade height because the blade's circumferential velocity ("V_x" in Fig. 2 of Schwaar) progressively increases with blade height, while the axial airflow velocity ("V_y" in Fig. 2 of Schwaar) remains essentially constant. As Schwaar points out, it is a "basic consideration of blade design" that the twist angle "t" shown in Fig. 2 increases with blade height. Schwaar, col. 3, line 66, to col. 4, line 21. Accordingly, the stagger angle limitation added to Alternate C is an inherent feature of all fan blades, and therefore it would at least have been obvious to incorporate it in the fan blades in Alternates A, B, and D.

Nor is there anything in Patent No. 6,071,077 to suggest that adding Alternate C's increasing stagger angle to a fan blade with a convergent blade tip and matching duct wall, and explicitly recited forward sweep angle in an outer region of the blade leading edge, provides any

advantage not present in a blade with a forward translated outer blade region and without a convergent blade tip (as in Alternates A and B). Accordingly, the subject matter of Alternate C would have been obvious from the subject matter of Alternates A, B, and D.

In addition, Alternate C is narrower than Alternate D, and therefore Alternate C anticipates Alternate D. M.P.E.P., supra. Alternate C is narrower than Alternates A and B because the latter omit Alternate C's limitations that the duct wall and blade tip profile are convergent and that the stagger angle increases with increasing blade height. Therefore, Alternate C anticipates Alternates A and B. Id.

CLAIMS CORRESPONDING TO THE COUNT

Claims 1-13 of Patent No. 6,071,077 Are Designated to Correspond to the Count

Claim 1. This claim is Alternate C of the Count. It is directed to the same patentable invention as each of Alternates A and B for the reasons already discussed above.

Claims 2 and 3. Claim 2 depends from claim 1. It recites a "tip region," but neither it nor its base claim 1 defines this term. Consequently, this claim essentially defines a region of the blade at the tip that constitutes an arbitrary amount of the blade's span. As a result, this limitation has no patentable significance.

Claim 2's "tip region" could be taken as being that portion of the blade in which the leading edge transitions from the rearward sweep in claim 1's intermediate height region to the forward swept in claim 1's third height region, although that is what claim 3 is understood to add to claim 2. However, if that is the meaning of this limitation, then it would have been obvious to choose any suitable place on the leading edge, such as the last 20% of blade height recited in claims 2 and 3, at which to begin the transition to forward sweep. Put another way, each of Alternates A and B taken from Application No. 09/874,931 teaches a blade with a leading edge

profile with an outer region that is moved forward to provide certain aerodynamic advantages. A fan engineer of ordinary skill, knowing the purpose of that blade geometry (see above), would have found it obvious to begin translating the outer region of the leading edge forward at the proper place, say the last 20%, as would be necessary to accomplish that purpose.

As for the recitation of a stagger angle at the blade tip of approximately 70° relative to the airflow direction, this limitation would have been obvious from the subject matter either of Alternate A or B for the same reasons that the recited extent of the forward swept tip region would have been obvious. That is, the fan engineer of ordinary skill, faced with a set of fan performance requirements, would have simply made a blade with a stagger angle at the tip that satisfies the requirement that the flow approach the blade at the proper angle. That the angle might be 70° relative to the airflow direction for a given fan stage thus would simply be a matter of proper engineering. Note also that the stagger angle "t" at the blade tip as measured in Fig. 2 of Schwaar is 70°.

Nor do the limitations from claim 1 relating to the convergent blade tip and forward sweep in the outer blade region impart separate patentability to claims 2 and 3, since they would not change the manner in which one of ordinary skill in the art would design a fan blade as discussed herein regarding claims 2 and 3.

Claim 4. This claim modifies claim 3, adding that the stagger angle of the mid-height region of the blade is in the range from approximately 30° to approximately 55° relative to the airflow direction.

This claim is obvious from either of Alternate A or B for the same reasons as claim 2 discussed above. That is, the stagger angle of a fan blade at any particular point on the blade is simply a function of good design technique, taking into account the

operating conditions to be encountered by the blade. In addition, Fig. 6 of Schwaar shows a swept fan blade with a stagger angle between 30° and 55° in the blade mid-height region.

Nor do the limitations from claim 1 relating to the convergent blade tip and forward sweep in the outer blade region impart separate patentability to claim 4, since they would not change the manner in which one of ordinary skill in the art would design a fan blade as discussed herein regarding claim 4.

Claim 5. This claim depends from claim 1, and adds the limitation that the sweep angle at any given point on the leading edge is less than the complement of the angle of a Mach cone at any other point on the leading edge of the blade at greater radius from the root.

Initially, it is conventional to use the concept of a "Mach cone" in analyzing supersonic flow over a gas turbine engine fan blade. U.S. Patent No. 3,989,406 to Bliss et al. discusses Mach cone angles, and Bliss's Figure 2 is a three-dimensional depiction of theoretical Mach cones associated with points on a fan blade leading edge. Bliss shows a blade with a leading edge swept to a degree that it is always subject to subsonic velocities, thus theoretically eliminating the difficulties associated with shock waves. This is the opposite of claim 5, in that Bliss's sweep angle (call it "σ") is greater than the complement of the Mach cone angle α (that is, $\sigma > 90° - \alpha$).

Claim 5 thus does no more than use different words to say the same thing as Alternates A and B. Put another way, consider what would happen if Alternate A and B did not meet claim 5: there would be no shock system to account for by using the leading edge configuration in those claims. Furthermore, Alternate B explicitly recites the presence of a shock wave in the flow,

meaning that its leading edge must have the Mach cone relationship recited in claim 5. Accordingly, the leading edge orientation in claim 5 is anticipated by Alternate A or B.

Claim 6. This claim depends from claim 1. It says that the shape of the pressure surface and suction surface of claim 1's blade creates a line of minimum static pressure points on the suction surface of the blade, which line is inclined with respect to the axial direction at a sweep angle which varies with span height of the blade, with a negative value in a region of subsonic flow over the leading edge.

Initially, a gas turbine engine fan blade is by definition an airfoil with a suction surface and a pressure surface. See Fig. 3 of Weingold. Accordingly, at each location along the blade height, the suction surface will inherently have a minimum static pressure point. The locus of those points will, again by definition, be a line of minimum static pressure points.

Good fan blade design required that the line of minimum static pressure points for a swept fan blade essentially follow the leading edge profile, as shown in Weingold. In other words, given the leading edge geometry of the blade in Alternate A or B, and conventional fan design practice as exemplified by Weingold, one of ordinary skill in the art would have inclined the lines of minimum static pressure points in the blade of Alternate A or B at a sweep angle that varied with blade height, and that sweep angle would have been negative in the inner, subsonic-flow region of the blade, just as in claim 6.

Claim 7. This claim depends from claim 6, modifying it to add that the sweep angle of the line of minimum static pressure points at a point on the line is less than the complement of a Mach cone angle at any other point on the line.

This claim relates to the same concept as claim 5. Mach cones associated with a blade's line of minimum static pressure points were known from Weingold, which is referred to in Patent

No. 6,071,077 at column 7, lines 25-27. Fig. 2a of Weingold illustrates Mach cones associated with a line of minimum static pressure points.

Weingold put the blade's maximum camber line 42 (associated with the line of minimum pressure points) behind the Mach cone associated with any inboard point of maximum camber. As in Bliss, the purpose of Weingold's geometry was to eliminate shock waves. Like claim 5, claim 7 puts the line of minimum static pressure points ahead of the Mach cone, the opposite of Weingold's geometry.

Accordingly, claim 7 does no more than recite a blade that creates shock waves, as discussed above in connection with claim 5. But unless the blade in Alternate A or B also creates shock waves, there is no reason for them to have the geometry that represents the invention embodied in those claims. And Alternate B explicitly recites the presence of a shock system, which means it even more clearly anticipates claim 7's recitation of a particular orientation of the blade's line of minimum static pressure points.

Claim 8. This claim is Alternate D of the Count. It is directed to the same patentable invention as each of Alternates A and B for the reasons already discussed above.

Claim 9. This claim modifies claim 8 by adding that the blade's intermediate region extends further than the inner region along the fan's axis of rotation.

Initially, this claim is difficult to understand because it is not clear what part of the blade's intermediate region is meant to "extend" further than the inner region along the rotational axis. Based on the disclosure at column 5, lines 23-51, and especially lines 26-28, of Patent No. 6,071,077, it appears that this claim means to say that the blade leading edge at the boundary between the inner and intermediate regions (segment S_5 in Figure 7a), is further upstream along the axis than the inner region (from the hub to segment S_5). As is the case with claims 5 and 7,

discussed above, claim 9 does no more than recite a feature of the blade in Alternate A or B. That is, a blade with a forward swept inner region and a rearward swept intermediate region must have claim 9's configuration. See Figures 1 and 2 of Application No. 09/874,931 and Figures 3a, 5a, and 7a of Patent No. 6,071,077, and Figures 4 and 6 of Schwaar.

Claim 10. This claim purports to modify claim 8, reciting that the inner duct wall of the fan casing at the fan rotor region is substantially convergent in the downstream direction. However, this is already a feature of Alternate D (claim 8), which means that claim 10 includes nothing to distinguish it patentably from Alternate A and B.

Claim 11. This claim purports to modify claim 8, reciting that the tip profile of the swept fan blades are substantially convergent in the downstream direction. As with claim 10, this is already a feature of Alternate D (claim 8), which means that claim 11 also includes nothing to distinguish it patentably from Alternate A and B.

Claim 12. This claim recites that the inner duct wall of the fan casing is not parallel to the tip profile of each of the multiple swept fan blades. Accordingly, it contradicts claim 8 (Alternate D), which recites that the blade tip profile is configured to "substantially correspond to the convergent inner duct wall." Nonetheless, it would have been well within the skill of a gas turbine engine designer to incorporate into Alternate A or B's fan casing an inner wall that is not parallel to the blade tip profile, as shown in U.S. Patent No. 4,012,165 to Kraig (Fig. 1; movable door 32).

Claim 13. This claim modifies claim 8 by adding that each of the fan blades includes a hub contacting surface that extends further than the tip profile along the axis of rotation, and as such relates to physical properties of the blade rather than its aerodynamic performance. The features recited in this claim are no more than the result of application by one of ordinary skill in

the art of routine design techniques to determine optimum blade geometry within the performance and mechanical design parameters for the engine under consideration. Patent No. 6,071,077 does not contend otherwise. In addition, Fig. 4 of Schwaar shows a swept fan blade with the claimed relationship between the blade root and tip.

Accordingly, all of the claims of Patent No. 6,071,077 are either anticipated by or obvious from Alternate A and B of the Count. By the same token, all of the patent claims, being narrower than Alternates A and B, anticipate the Count. M.P.E.P., supra.

Claims 18, 19, 22, and 23 of Application No. 09/874,931 Are Designated to Correspond to the Count

Claim 18. This claim is Alternate A of the Count. It is directed to the same patentable invention as each of Alternates C and D for the reasons already discussed above.

Claims 19 and 22. These claims are either identical to or based closely on dependent claims 9 and 13 of Patent No. 6,071,077, respectively. Accordingly, they are obvious from the Count for the same reasons discussed above in connection with Patent No. 6,071,077 claims 9 and 13.

Claim 23. This claim is Alternate B of the Count. It is directed to the same patentable invention as each of Alternates C and D for the reasons already discussed above.

Accordingly, all of the claims of Application No. 09/874,931 are either anticipated by or obvious from each alternate version of the Count. By the same token, all of the application dependent claims, being narrower than the Count, anticipate the Count. M.P.E.P., supra.

Benefit of the Filing Date of Earlier Applications

Application No. 09/874,931 is a continuation of Application No. 09/343,736, filed on June 30, 1999, to reissue U.S. Patent No. 5,642,985, issued on July 1, 1997, from Application

No. 08/559,965, filed on November 17, 1995. Since all of those applications share a common disclosure, Application No. 09/874,931 is entitled to benefit of the November 17, 1995, filing date of Application No. 08/559,965.